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June 4, 1957

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Gentlemen:

In accordance with your request we herewith respectfully submit a proposal to design and construct four lightweight collapsible lenses.

The price for these units would be $ 9,865.00 F.O.B. Washington, D.C. and would include reproducible drawings and six (6) copies of an instruction manual with photographs of the units.

Delivery would be within five (5) months from the date of contract.

Very truly yours,

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Lightweight Collapsible Lens

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Lightweight Collapsible Lens

June 4, 1957 Ref: PR - 238 - 1

1.0 Statement of the Problem.- A desire has been expressed to design and manufacture a lightweight, collapsible lens barrel mount for the f:6.3, 40 inch Astro lens. The present collapsible lens mount, which utilizes part of the standard Astro lens mount, with aluminum tubes and machined aluminum mounting rings, weighs approximately 20 pounds. It is understood, that to save weight the iris diaphragm assembly may be eliminated. A goal of 8 pounds has been set. The weight of the glass elements is estimated as 4.5 pounds.

2.0 Approach to a Lightweight Design.- The present lens mount design is the result of several compromises, dictated by the following facts:

(a) The tubing sizes chosen were made from the very limited available sizes.

(b) Wrought aluminum alloy was used for the tube ring sections.

(c) The front part of the standard Astro mount was used to preserve the diaphragm assembly.

To reduce weight to the extent desired, extremely careful redesign becomes necessary.

We have analysed the problems of weight reduction in this design on the basis of the following criteria:

(a) The best material choice.

(b) The best fabrication method, using the chosen material.

2.1 Comparison of Physical Constants of Available Materials.- The following is a tabulation of pertinent facts on various available materials:

Table I

Material	Density lbs/in^3	Modulus of Elast psi x 10^6 "E"	"E" to Density Ratios
Aluminum Alloy	0.097	10.0	1.03
Steel	0.284	28.5	1.00
Magnesium	0.063	6.5	1.03
Fiberglas & Resin	0.061	1.7	0.28

2.2 Choice of Material.- The tabulation above shows aluminum alloys, steel and magnesium to have nearly identical modulus of elasticity to density ratios. Glass reinforced plastics appear to be well below the other four.

An analysis for minimum tube wall thickness with aluminum shows that a section of .002 in. would just buckle under the assumed loads of structure weight, lens, and camera loads. This is probably a conservative estimate since it assumes that the tube ends are not constrained.

Since the critical buckling moment is a function of the square of the wall thickness, a reasonable wall of, for example .015 in. would produce a section whose critical moment is 50 times that with the minimum wall thickness above.

2.2.1 Fabrication Considerations.- The foregoing analysis

indicates that very thin walls may be used in the tube sections. Since the walls have a finite limit, due to fabrication methods, titanium would appear to be the best choice, magnesium next, and aluminum third. Titanium would be difficult to obtain and fabricate. Magnesium is hazardous to machine, and all of the tubes would require castings. Aluminum alloy appears to be a quite satisfactory choice for the tubes. These tubes could be wrought tubing machined to the proper thickness, butt welded, wrapped sheet material, or spun aluminum sections.

2.3 Proposed Design.- A restatement of the problem has both permitted, and required a change in the design concept. It is now believed that a preferred design would have the following features:

(a) Telescoping lens barrel sections will be fabricated by spinning aluminum tubes, with end flanges.

(b) The end flanges will be reinforced with thin rings.

(c) Bayonet pin couplings with either cam or spring loading will be used to couple tube sections.

(d) The lens barrel would fit either the Exakta or the Alpha 35 mm cameras.

(e) A simple cam focusing device of limited range, as unaffected by dirt as possible, would be provided.

(f) The elimination of the iris diaphragm and the use of approximately seven tube sections and a hood, should permit a total collapsed

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length of about seven inches. This feature has been made possible by the use of the spun tube sections and a simple bayonet lock for each section. At the same time it is estimated that the total weight including the glass elements will be under eight pounds.

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